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A HISTORY OF THE NATIONAL RESEARCH COUNCIL 1919—1933

FOREWORD

DURING the year 1932 the Committee on Policies of the National Research Council was directed by the Executive Board to make a survey of the organization of the Council and to present recommendations in regard to needed changes. As a preparation for their labors they called upon the officers of the Council and the chairmen of the several divisions for a report upon the activities of the Council since its organization upon a peace-time basis in 1919.

The Council has felt that it is desirable to bring the substance of this report to the attention of the scientific workers of the country, since what it has been able to accomplish has depended so largely upon their interest and cooperation. Accordingly, a summary of the report will be published in SCIENCE, through the courtesy of the editor, as a series of short articles prepared under the supervision of Dr. Fernandus Payne, Chairman of the Division of Biology and Agriculture, and Dr. A. T. Poffenberger, chairman of the Division of Anthropology and Psychology.

The first of this series of ten articles follows, describing briefly the organization of the council and its general activities. Subsequent articles of the series will be published in later issues of SCIENCE.

W. H. HOWELL,
Chairman, National Research Council

I. GENERAL ORGANIZATION AND ACTIVITIES

By Dr. ALBERT L. BARROWS
ASSISTANT SECRETARY

THE origin of the National Research Council lies in an offer which the National Academy of Sciences made of its services to President Wilson following the spring meeting of the Academy in 1916, when it was seen that the United States would probably become involved in the world war. The services offered by the Academy were for the coordination of the non-governmental scientific and technical resources of the country with the military and naval agencies of the Government, in the interests of national security and preparedness for the emergency which this country was then facing. A similar crisis had, in fact, brought about the organization of the National Academy for the assistance of the Government in 1863.

President Wilson at once accepted this offer, and at his request the Academy organized a central committee which it called the "National Research Council." This committee set up a number of special technical committees on various problems involved in the mobilization of the scientific and technical resources of the country. During the ensuing two years the National Research Council was engaged largely in the service of the Federal Government, acting as the Department of Science and Research of the Council of National Defense, and also as the Science and Research Division of the Signal Corps of the Army, and in cooperative relationship with other branches of the Government to meet its military and naval needs.

By the close of the war the recognition of the valuable services which such an organization might continuously render to the country under peace conditions had become apparent. This was particularly appreciated in view of the "new and important possibilities . . . opened through the heavy demands upon science and research which had arisen through the exceptional necessities brought about by the war." Accordingly, President Wilson issued an executive order on May 18, 1918, requesting the National Academy to perpetuate the National Research Council. The purpose of the Council is expressed in its Articles of Organization as follows:

> It shall be the purpose of the National Research Council to promote research in the mathematical, physical, and biological sciences, and in the application of these sciences to engineering, agriculture, medicine, and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare, as expressed in the Executive Order of May 11, 1918.

During the early part of 1919 the Research Council was reorganized by the Academy on a permanent basis centering around an executive board of some 44 members as a central governing body, with certain additional general committees called divisions, representing the major fields of interest of the Council. The number of these divisions is now eleven, four of them representing general relationships of the Council with the Federal Government, with international scientific organizations, with educational institutions and with scientific agencies of the state governments. The divisions of science and technology number seven, including the physical sciences, engineering and industrial research, chemistry and chemical technology, geology and geography, the medical sciences, biology and agriculture, and anthropology and psychology. The membership of these several divisions ranges in number from 18 to 44. The Council also maintains a research information service for the organization of general data and for assistance in locating sources of information.

The reorganization of the National Research Council in 1919 further provided for the enlistment of the cooperation of research men throughout the country, by inviting the national technical and scientific societies of the United States to designate representatives in the membership of the Council. In the seven divisions of science and technology these society representatives constitute the majority of the divisional membership. Each division also contains in addition a limited number of members-at-large, selected by the division. At present 79 societies are affiliated with the National Research Council in this way. The total number of members of the Council in its executive board and in its divisions is this year 285. The administrative and technical committees through which the Council conducts most of its operations number 135, and include 888 members in addition to the officers and members of the Council, making a body of 1,173 scientific men directly related to the Council, besides a large number of other collaborators in its various undertakings.

The chairmen of the Council and the chairmen of its executive board, since the inception of the Council, have been:

George E. Hale,	1916–1919
John J. Carty,	1916–1918
James R. Angell,	1919–1920
H. A. Bumstead,	1920
John C. Merriam,	1921–1923
Gano Dunn,	1923–1928
George K. Burgess,	1928–1932
William H. Howell,	1932–1933

The office of secretary, executive secretary or permanent secretary of the Council during this period has been filled by:

Cary D. Hutchinson,	1916–1918
John Johnston,	1918–1919
A. O. Leuschner,	1919
Vernon Kellogg,	1919–1931

In addition to relating the National Research Council to the national research societies of the country, the reorganization of the Council in 1919 provided in each of its divisions of science and technology for an active leader as the chairman of the division. Each division chairman during his term of office has given his major attention to the promotion of the projects sponsored by his division, with the constant assistance of an executive committee which has met with him at stated intervals. This leadership, supported by the extensive relationships afforded through the membership of the divisions and by other facilities offered by the Council, has been the unique feature in its organization.

During the past year the Research Council has been giving particular study to the problem of its organization and relationships in the light of its experience in the past thirteen years. Certain changes, principally in the direction of economy of organization, which are to be put into effect next year, will, it is hoped, result in a simplification of its administration and in an increased effectiveness.

The financial resources of the Council came from various sources during the war years, but largely from the Engineering Foundation and from the Federal Government. Subsequently, the Council has been supported in its general administration wholly from private sources and mainly on the income from an endowment provided by the Carnegie Corporation of New York. Of the original gift of $5,000,000 from the Carnegie Corporation, about one third was taken for the erection of a building in Washington, D. C., to service as headquarters for the National Academy of Sciences and for the National Research Council.

In addition to its income from endowment, which is used mainly for administrative expenses, the Council among its other activities administers funds placed in its hands for special research purposes. These funds in recent years have totalled about $800,000 annually. The purposes for which they have been used include (1) the maintenance of research fellowships, (2) the support of coordinated programs of cooperative research through the allotment of grants to collaborators in these projects, (3) the awarding of individual grants in support of research, and (4) the administration of the funds of independent scientific bodies without the assumption, however, of responsibility for their work.

One of the most important of the undertakings of the Council has been the administration of three series of post-doctorate fellowships in physics, chemistry and mathematics, in the medical sciences and in the biological sciences, including anthropology and psychology and the fundamental aspects of forestry and agriculture. These fellowships are supported on funds furnished by the Rockefeller Foundation, and, in the earlier years of the series of medical fellowships, by the General Education Board also. The purpose of these fellowships is to give promising investigators at the beginning of their careers additional years of training and experience in research. At present about 140 appointments are made annually at basic stipends of from $1,600 to $1,800 per year, with additional allowances for dependents. Some of these fellows are appointed to study abroad. Altogether about 850 fellows have been appointed, about one third of the total number of applications. Of the 700 or more past fellows approximately four fifths now hold positions in educational institutions.

For the past three years the Council has also had the administration of a research aid fund for the assistance mainly of individual research. During this time 375 grants have been made to individuals and 19 grants for conferences and other general research purposes. The total amounts thus granted is $250,-775.01.

Among other general undertakings the Council has sponsored the publication of the "International Critical Tables of Numerical Data of Physics, Chemistry and Technology," in seven volumes, with a comprehensive index now in the course of preparation. The Council has also given its assistance to the collection of funds in this country for the publication in Paris of the "Annual Tables of Numerical Data of Chemistry, Physics, Biology and Technology." At the request of the trustees of the Chicago "Century of Progress" Exposition, the Council organized a group of committees in 1929 and 1930 to advise the trustees in regard to certain aspects of the plans for the scientific exhibits at this exposition. The Council has acted as the fiscal agent for the Tropical Plant Research Foundation, for the Crop Protection Institute and for the Commission on Standardization of Biological Stains in the early years of these organizations, and still administers the editorial funds for the "Biological Abstracts." The Council has also supported the work of the American Geophysical Union, which is the principal coordinating agency in the United States for research in geodesy, oceanography and related subjects.

In addition to the material support of research, represented by the research funds administered by the Council, largely through committees of the divisions

of the Council, other special committees of the divisions have sponsored a wide variety of enterprises which require not so much funds as other forms of assistance. These enterprises have included the encouragement of research through the coordination of investigations in certain fields, the preparation of surveys of the conditions of research in special subjects, and the holding of conferences for the discussion of the current status of research in problems of large scope. The chairmen of divisions have themselves undertaken special studies of conditions affecting the course of research in their respective fields. A long series of publications has been issued in a *Bulletin* and a *Reprint and Circular Series,* consisting of reports of committees of the Council and the reissue of timely articles in various fields of scientific research. Several books have been prepared under auspices of committees of the Council and have been issued through commercial publishers.

"The primary function of the Council is the promotion of research in the United States; . . . it justifies its existence not through the maintenance of an organization but solely through the definite projects which that organization is maintaining and promoting." With this object in view the Council has functioned as an agency through which many cooperative undertakings have been initiated. It has furnished auspices under which scientific men have acted by a wide variety of means for the encouragement of research. By virtue of its organization and its affiliations it has been in position, also, in many cases, to bring together the workers and the benefactors of science in a common endeavor to promote the advancement of knowledge. Whatever has been accomplished, however, in the support of research has been possible mainly because of the personal contributions of the large body of American scientific men associated with the Council, who have collaborated in these enterprises and have given generously to them of their time and effort. The Council relies upon this cooperation from the scientific men of the country for the successful operation of the mechanism which has been set up.

II. DIVISION OF PHYSICAL SCIENCES[1]

By Professor F. K. RICHTMYER
CHAIRMAN

THE Division of Physical Sciences of the National Research Council, formally organized May 1, 1919, was the natural outgrowth of the activities of the Physics Committee and later the Division of Physics, Mathematics, Astronomy and Geophysics of the Council, and also of the Science and Research Division of the Signal Corps, which rendered important research services during the war. For perhaps the first time, it was realized that, in addition to direct results, the indirect benefits of directed cooperative effort among scientists was very great. The men who sponsored the Division of Physical Sciences had all seen war service in one way or another, but the organization of the division which they set up and the program of activities which they initiated were directed toward the peace-time development of the sciences of physics, mathematics and astronomy. Accordingly, "the primary object of the Division is to stimulate and to facilitate research in the various related sciences grouped in the Division."

Two methods were adopted to accomplish this purpose. First, the Division was so organized as to bring together in its organization men in the different sciences and geographically separated—it being believed that such association would promote better acquaintance and would pave the way for spontaneous cooperation. Second, the policy was adopted of setting up research committees to survey and summarize research in various fields and to prepare short monographs which should be "distributed to all scientists in the group . . . to put the readers *au courant* with the present state of the science as regards the subject of the monograph." A third method was soon added. The Rockefeller Foundation generously provided support for the now well-known National Research Fellowships in physics (including astronomy), chemistry and mathematics. And the Division of Physical Sciences was asked to organize and to sponsor a fellowship board to administer these fellowships.

The organization of the division provided for a chairman, vice-chairman, members-at-large and representatives from each of the several national societies in the fields of science included within the division. During the past several years the division has contained twenty-one members, of which three are members-at-large and seventeen represent the following societies: American Astronomical Society, Acoustical Society of America, American Mathematical Society, American Physical Society, Mathematical Association of America and the Optical Society of America. Meetings of the division are held annually to discuss matters of general policy, work of the preceding year and plans for future activities.

It will be not without interest to record the names

[1] This is the second of a series of ten articles prepared to describe briefly the nature of the activities with which the National Research Council has been engaged during the past fourteen years.

of those who have served as chairmen of the division since its organization:

1918–1919—R. A. Millikan
1919–1920—C. E. Mendenhall
1920–1921—Augustus Trowbridge
1921–1922—Henry G. Gale
1922–1923—William Duane
1923–1924—Oswald Veblen
1924–1927—Joseph S. Ames
1927–1930—Dayton C. Miller
1930–1933—F. K. Richtmyer

Since 1919, there have been associated with the division as officers, or members, or as members of research committees, altogether some 355 *different* persons. Many of these persons, through their connection with the division in one way or another, have become mindful of the value of cooperative support of research, as well as of the latent possibilities of the service which such an organization as the National Research Council can render. These contacts have tended to emphasize the community of interest which scientists have in the promotion and general well-being of science as a whole.

Recognizing the importance of these indirect influences, the division has not thought it wise to undertake a great variety of activities in the promotion of research in physics, mathematics and astronomy. Rather, the efforts of the division have been concentrated on the formation of various research committees to survey and to report upon timely research topics, whenever such a survey would seem to serve a useful purpose.

Since the organization of the division in 1919 there have been appointed a total of thirty-eight research committees in such subjects as: Acoustics, Algebraic Numbers, Analysis Situs, Atomic Structure, Celestial Mechanics, Electrodynamics of Moving Media, Hydrodynamics, Line Spectra of the Elements, Luminescence, Numerical Integration, Photo-Electricity, Physics of the Earth with various subsidiary committees, Quantum Theory, Radiation in Gases, Theories of Magnetism, X-rays and Radioactivity, X-ray Spectra and many others. Of these committees, seven are still active. A large proportion of the remainder, having completed the reports for the preparation of which they were appointed, has been discontinued.

In addition to numerous articles in current scientific periodicals, reports to the number of thirty-three prepared by these committees have been published or are in press as bulletins of the National Research Council. These bulletins have ranged from pamphlets of forty or fifty pages up to large volumes of several hundred pages. They are sold at cost of manufacture. The subjects covered are varied; to mention only a few: The Quantum Theory (1920); Problems of X-ray Emission (1920); The Present Status of the Atomic Problem (1921); Certain Problems of Acoustics (1922); The Present Status of Visual Science (1922); Algebraic Numbers (1923); Critical Potentials (1924); Radioactivity (1925), reprinted (1929); Quantum Principles of Line Spectra (1926), reprinted (1928); Molecular Spectra in Gases (1926), reprinted (1930); Hydrodynamics (1932).

As illustrative of the service which the division is rendering in the preparation of these monographs, special mention should be made of the Committee on the Physics of the Earth, organized by Dr. Joseph S. Ames during his term as chairman. This committee, with a total membership of approximately 100 physicists, chemists, geologists, geophysicists and others, is divided into nine subcommittees as follows: The Figure of the Earth; Age of the Earth; Meteorology; Oceanography, Volcanology; Seismology; Internal Constitution of the Earth; Terrestrial Magnetism and Electricity; and Field Methods for Detecting Unhomogeneities in the Earth's Crust. The first six of these subcommittees have completed their reports, and they have been published in the Bulletin Series of the National Research Council. Reports from the remainder are nearing completion. This group of bulletins is a noteworthy contribution to the literature of this important subject. Although intended to stimulate research in the general field of earth physics, the bulletins are nevertheless of particular interest to the general scientific reader, since for the most part they are written in non-technical language.

It is the purpose of the division to form new committees whenever work in any field of research would be furthered thereby. It has been felt that the research bulletins have been of special service to investigators in providing up-to-date surveys not otherwise available; and in suggesting new problems and lines of attack. Research, particularly in pure science, is most effectively carried on as a result of individual initiative, rather than by the organized parcelling out of problems. The division has never attempted to "organize" research.

In 1920 and 1922, the division received from the National Research Council a sum of $1,500 to initiate a revolving fund for the publication of mathematical books. It was the purpose of this fund to underwrite the publication of important mathematical books which could not find publication through commercial channels. To date three such books have been published by and from this fund. Royalties received have slightly exceeded expenditures.

In 1926 and 1928, the division received from the International Education Board a total sum of $20,000 in support of astronomical research surveys under the direction of Professor A. O. Leuschner.

As was mentioned above, the Fellowship Board in

Physics, Chemistry and Mathematics—the first of the three National Research Council Fellowship Boards now operative—was organized under the auspices of the division in 1919. The administration of these fellowships has been one of the chief activities, as well as one of the major accomplishments, of the division. The chairman of the division serves, *ex officio,* as the secretary of the board, which in addition to its chairman and secretary consists of ten members—three in physics, three in mathematics and four in chemistry, the last named including, *ex officio,* the chairman of the Division of Chemistry and Chemical Technology. The board meets once each year, in April, for the appointment of fellows for the ensuing year.

Appointments are for one year, and are offered only to those who have the Ph.D. or who have had equivalent training. A limited number of appointments are made for work abroad, but for the most part fellows work at the various universities and other research institutions in the United States and Canada. Appointments are frequently renewed for one year.

Since 1919 the Fellowship Board in Physics, Chemistry and Mathematics has considered upwards of 1,000 applications. In that period nearly 400 appointments have been made, over fifty of which have been for work abroad. At present there are sixty fellows active, of whom six are working abroad. In this period nearly $1,300,000 has been paid to fellows in stipends.

About 39 per cent. of appointments have been in chemistry, 39 per cent. in physics, and the remainder in mathematics.

Fellows have been appointed from (that is, have taken their respective Ph.D's in) some thirty-five different universities in America. While the larger proportion of fellows have come from the larger universities, a study of the distribution shows that the relative number of appointees from the several universities is roughly proportional to the number of Ph.D's conferred by each.

There is an equally wide distribution of institutions in which fellows have worked. Some thirty-two American and twenty-five foreign universities and research institutions have cooperated with the National Research Council in offering facilities to fellows to carry on research. In the aggregate this service which the various institutions have thereby rendered is very great indeed.

It was the original purpose of those who sponsored the fellowship program to provide the more able young scientists with opportunities to acquire "momentum" in research, before settling down to permanent positions. That this objective is being realized is at once evident from a consideration of the present location and activities of past fellows. Nearly 80 per cent. of past fellows hold positions in educational and similar research institutions, where not only are they continuing their researches, but they are in many cases leaders in promoting the research program of the institution. The remainder are connected with industrial or governmental institutions. *With very few exceptions, all past fellows are entering upon active research careers.* There are many who would heartily endorse the statement that had the National Research Council engaged in no activity other than the promotion and administration of the National Research Fellowships, its existence would have been justified.

The services of the Division of Physical Sciences have been utilized in providing a sponsorship for the American sections of several international unions. At present there are organized under the auspices of the division the American sections of, respectively, The International Astronomical Union, The International Scientific Radio Union and the International Union of Pure and Applied Physics.

Each of the several divisions of the National Research Council can be of most effective service by organizing and by engaging in activities so as most adequately to meet the needs of the particular group of sciences concerned, due regard being had for other agencies in the field, such as societies, research institutes, academies and the like. In common with other divisions, it is the policy of the Division of Physical Sciences to stand ready to be of service wherever and whenever such service can be best rendered, and to cooperate to the fullest extent with other agencies so as to avoid needless duplication of effort.

OBITUARY

MEMORIALS

A BRONZE tablet in memory of Josiah Royce was placed on April 9 by the Harvard Club of San Francisco in the library of his native city, Grass Valley. At the ceremony Rudolph Altrocchi, professor of Italian and chairman of the department of Italian, and now president of the Harvard Club of San Francisco, presided. A paper on Josiah Royce was read by Jacob Loewenberg, vice-president of the club and professor of philosophy in the University of California. Dr. Royce was professor of philosophy at Harvard University from 1882 until his death in 1916.

A BRONZE bust of Ernest Haeckel, the German nat-

uralist, was unveiled at the Cincinnati Society of Natural History on January 18.

SIR HARRY GOSCHEN, chairman of the board of the London School of Hygiene and Tropical Medicine, has received from Mr. Robert Holland Martin and the committee of the Avebury Memorial Fund a sum of £2,000 for the establishment in the school of a fund in memory of Lord Avebury, to be applied to the advancement of study and research in entomology.

SIR F. GOWLAND HOPKINS has unveiled a plaque which has been placed in the Halliburton laboratory of physiology at King's College, London, in memory of Professor W. D. Halliburton, who was professor of physiology at the College from 1890 until 1923. *Nature* writes: "When Professor Halliburton was appointed, the laboratory was on the Embankment in small and badly lit rooms where Ferrier and Lister had worked. Yet, by his enthusiasm, he managed to attract many young physiologists to the college. The present laboratory is the result of his great efforts during his tenure of office as professor of physiology." Professor Halliburton was elected a fellow of the Royal Society in 1891 and died on May 21, 1931, aged seventy years.

A CORRESPONDENT of the London *Times* writes from Bournemouth recently that the evidence supplied by an inscription on a gravestone in the parish churchyard of the village of Worth Matravers, near Swanage, Dorset, shows that Edward Jenner, who discovered inoculation by cowpox, or vaccination, as a preventive of smallpox, was forestalled by two years by Benjamin Jesty, a Dorset farmer. The facts are known to the medical profession, but not generally. Edward Jenner's first inoculation by cowpox is recorded as having been made on a boy in May, 1776. Jesty's gravestone inscription shows that he inoculated his wife and two sons with cowpox in 1774. The gravestone was noticed recently by a medical man now practising in Bournemouth, who was walking through Worth Matravers. The inscription relates that Benjamin Jesty "was an upright honest Man: particularly noted for having been the first Person known that introduced the Cow Pox by Inoculation, and who from his great strength of mind made the Experiment from the Cow on his Wife and two Sons in the year 1774." Adjoining Benjamin Jesty's grave is that of his wife, and the fact that she died at the age of 84 in 1824, 50 years after the experiment, proves fairly conclusively that the experiment made on her by her "strong-minded" husband did not affect her health.

RECENT DEATHS

FREDERICK E. BEACH, assistant professor of physics at Yale University, from 1895 to 1931, died in his seventieth year on April 6.

LUTHER MARION DEFOE, emeritus professor of mechanics at the University of Missouri, died on April 3, in his seventy-third year.

DR. CLARENCE ALBERT SHORE, for twenty-five years director of the North Carolina State Laboratory of Hygiene, died on February 10, at the age of sixty years.

DR. JOHN MILLAR THOMSON, emeritus professor of chemistry at King's College, London, died on March 22, at the age of eighty-four years.

WALTER EDMUND ROTH, anthropologist and curator of the British Guiana Museum, died on April 6. He was seventy-two years old.

THE death is announced of Dr. Friedrich Rinne, professor of mineralogy and petrography at Leipzig.

SCIENTIFIC EVENTS

PROPOSED PLANETARIUM FOR THE AMERICAN MUSEUM OF NATURAL HISTORY

F. TRUBEE DAVISON, president of the American Museum of Natural History, and George McAneny, president of the Regional Plan Association, recently discussed with Mayor O'Brien, of New York City, plans for the creation of a Planetarium Authority. Mr. Davison has also discussed the plan with Governor Lehman. The proposal has been under consideration for several years, but the plans were postponed because of lack of funds.

At a recent luncheon at the Museum, Mr. Davison explained that it was hoped to obtain state legislation that would permit the creation of a Planetarium Authority similar to the New York Port Authority, with power to issue bonds. The measure would also enable the city to transfer to the authority, for a time, some of the city-owned museum land, just north of the African Hall.

Mr. Davis said in part:

> The bill is purely a permissive measure. It does not bind the museum to take any action toward the planetarium project and it does not commit the city to endorse the project unless it is in whole-hearted accord with the museum's attitude.
>
> The reason for the measure is that we hope to borrow the money from the Reconstruction Finance Corporation, provided we are satisfied that the planetarium will be self-supporting; in other words, the planetarium, through admission fees, must not alone pay its own way with

respect to maintenance and so on, but must also yield enough income to retire any bonded indebtedness incurred in connection with its construction.

The reason we ask for legislation now is because it is needed in the event we determine to put the completed project before the city for further action.

Tentative plans call for a planetarium similar to the Adler Planetarium in Chicago. It would seat 600 persons. Though admission would be charged until the bonds have been paid, school children would be admitted free at specified times, when they attended as part of their classroom work.

WEATHER STATION ON MT. WACHUSETT

ON this isolated peak in central Massachusetts, 2,018 feet above sea-level, a new meteorological station has been established under the auspices of Blue Hill Observatory, Harvard University, in connection with the work of the International Polar Year. Unlike the Mt. Washington Observatory, however, there will not be resident observers. A meteorograph, designed and built by Professor S. P. Fergusson to run two or three months without attention, is keeping the record of wind direction and velocity, atmospheric pressure, temperature and humidity.

According to a news release of Science Service, permission to install the apparatus in the fire lookout's tower on the top of the hotel on Mt. Wachusett was granted by Everett W. Needham, superintendent of the Wachusett State Reservation. The meteorograph and the exposed elements were prepared and adapted by F. B. Towle and his son, Philip, of Holden, Massachusetts, who will also look after the station weekly.

The wind vane and three-cup anemometer, loaned by the U. S. Weather Bureau, are exposed a few feet above the top of the tower and are connected to the pens which record the wind direction and velocity on the large drum of the meteorograph in the fire-lookout room. Under the eaves of the summit-house tower, the temperature and humidity elements are exposed in a louvered box to protect them from the full force of the gales that beset this summit. A coil of brass and steel is indicating the temperature, while a bundle of 150 strands of child's hair, prepared by Clifford L. Davis, of Worcester, operates the humidity recorder. The motion of these elements is transmitted several feet to the pens on the recorder by means of 100-year-old light wooden connecting rods from an old church organ which are hung on sewing machine needles.

Mt. Wachusett stands alone and is exposed to more or less frequent high winds. Mt. Washington, 127 miles away, is sometimes visible in extremely clear weather, and Blue Hill, 45 miles distant, is also in sight. Ice storms occur quite often. At the beginning of this month, the east side of the hotel was plastered with almost solid ice, two to three inches thick.

Mt. Wachusett is characterized by a strong edition of the typical ever-changing New England weather. It is intermediate between the arctic character of Mt. Washington and the more temperate weather of Blue Hill, where are the other two mountain and hill top stations of New England. These three stations will help to show how sudden weather changes progress over New England.

ANNUAL REPORT OF THE BROOKLYN BOTANIC GARDEN

THE twenty-second Annual Report of the Brooklyn Botanic Garden records the facts that the garden closed the year without a deficit and with more than $11,400 added to its permanent endowment fund and with the 1933 budget balanced. The director points out that this accomplishment has been made possible only by the most rigid economies.

During 1932, there was a registered attendance of 1,307,964, which was an increase of more than 200,925 over the preceding year. The registered attendance for May (232,737) was nearly half the attendance for the entire year of 1924. The week-end attendance of May 14 and 15 was 38,804.

4,555 packets of seeds of American wild flowers were supplied to more than 120 gardens in more than 20 foreign countries. The request for these packets of seeds was about 500 in excess of the garden's ability to respond.

During the year, lectures, addresses, informal talks and class exercises reached a total number of 1,762. 780 adults were enrolled in classes and 597 children. Teachers from the public schools brought more than 41,000 pupils to the garden for instruction, and 6,105 teachers were supplied with living plant material and sterilized agar for class work for the instruction of 257,527 pupils. 740 potted plants were placed in the classrooms of public schools and more than 670,000 packets of seeds were supplied to pupils for planting in school and home gardens. The school service of the Brooklyn Garden now extends to all five boroughs of Greater New York.

Progress in the research program of the garden is also recorded covering the subjects of plant pathology, genetics and plant breeding, forest pathology, ecology and systematic botany. Eight research students were registered during the year. Progress in the development and beautifying of the grounds is also recorded.

The library of the garden now has more than 17,450 volumes and more than 30,900 bound pamphlets. The library of the American Fern Society is now deposited there. In contrast to the experience of many organizations and many institutions, the garden re-

ports an increase of new members for 1932 of 97, or 9.3 per cent.

The report includes an urgent plea for an addition of not less than one million dollars to the endowment of the garden in order to care for the increased service which it is being called upon to render to the general public and to botanical science and education.

FELLOWSHIPS OF THE CHARLES LATHROP PACK FOREST EDUCATION BOARD

MAKING its fourth annual award of fellowships for training leaders in forestry, the Charles Lathrop Pack Forest Education Board announces its selection of three American and two Canadian fellows for the year 1933. The fellowships were established to encourage men to obtain advanced training to better qualify them for leadership in forestry and in the forest industries. The successful candidates are:

Walter U. Garstka, instructor in forestry, Penn State Forest School. To make organic analysis of leaf litter, immediately after its fall in the autumn, collected from forests growing on podzolized and brown-earth soils.

Harold R. Hay, graduate student, University of Wisconsin. To make a study of changes in the physical properties and chemical constituency of wood subjected to steam treatments.

John Edward Liersch, junior forester, British Columbia Forest Service. To continue a demonstration begun under Charles Lathrop Pack Fellowship awarded in 1932 regarding the practicability of economic selection in the Douglas fir region.

Nicholas T. Mirov, graduate student, University of California. To make a study of transpiration by different forest cover species with reference to precipitation and to moisture content of the soil.

Louis René Scheult, graduate student, University of Toronto, Toronto. To make a regional study of forest development.

This is the fourth award of fellowships by the board. They are available to Americans and Canadians for further training in the general practise of forestry, in the forest industries, in the teaching of forestry, in forest research, or in the development of public forest policy.

The directors of the board are: Henry S. Graves, dean, Yale Forest School; Samuel T. Dana, dean, School of Forestry and Conservation, University of Michigan; John Foley, forester, Pennsylvania Railroad; William B. Greeley, secretary-manager, West Coast Lumbermen's Association; Arthur Newton Pack, director, Charles Lathrop Pack Forestry Trust; E. O. Siecke, director, Texas Forest Service; Ellwood Wilson, acting professor of silviculture, New York State College of Agriculture; Hugo Winkenwerder, dean, College of Forestry, University of Washington, and Raphael Zon, director, Lake States Forest Experiment Station.

The offices of the board are at 1214 Sixteenth Street, N.W., Washington, D. C., and correspondence should be addressed to Tom Gill, secretary.

SCIENTIFIC NOTES AND NEWS

DR. HENRY NORRIS RUSSELL, research professor of astronomy and director of the observatory at Princeton University, president this year of the American Association for the Advancement of Science, will deliver the Halley Lecture at the University of Oxford on June 1. His subject will be "The Composition of the Stars."

DR. ROBERT A. MILLIKAN, of the California Institute of Technology, has accepted the invitation of Oberlin College to deliver the Centennial Commencement address on June 20. Dr. Millikan was recently reelected alumni trustee for a term of six years; he has served on the Board of Trustees since 1918.

DR. IRVING LANGMUIR, of the General Electric Company, Schenectady, New York, will be made an honorary member of the School of Engineering Alumni Association of Columbia University at the annual dinner on April 26. Dr. Langmuir and Dr. Michael I. Pupin will be the principal speakers.

DR. WALDEMAR LINDGREN, Rogers professor of economic geology and head of the department of geology at the Massachusetts Institute of Technology, will retire at the end of the academic year.

THE Paris faculty of medicine has conferred the degree of doctor, *honoris causa*, on Professor Sanarelli, director of the Hygienic Institute of the University of Rome.

THE Bessemer Gold Medal of the British Iron and Steel Institute has been awarded to Dr. W. H. Hatfield, director of research in the firm of Messrs. Thos. Firth and John Brown, Ltd., in recognition of his distinguished services in the advancement of metallurgical science.

THE Gold Medal of the British Institution of Mining and Metallurgy, the highest distinction in its power to confer, has been awarded to Sir John Cadman in recognition of his work in the advancement of technical education and the development of the mineral industries, and of his distinguished public services. The following awards have also been made: The Consolidated Gold Fields of South Africa Gold Medal to Mr. Charles Arthur Banks for his paper on

"Air Transportation of Gold Dredges in New Guinea"; and the premium of 40 guineas conjointly to Mr. J. L. Francis and Mr. John C. Allan for their paper on "Driving a Mines Drainage Tunnel in North Wales"; the William Frecheville Student's Prize of ten guineas to Mr. Gordon J. Williams for his paper on "The Genesis of the Perrunal-La Zarza Pyritic Orebody, Spain."

Nature reports that the prize of the Institute of Physics for the best paper published in the *Journal of Scientific Instruments* during the year 1932 has been awarded to Mr. E. Lancaster-Jones, of the Science Museum, for his paper on "The Principles and Practice of the Gravity Gradiometer," and the prize for the best contribution to the Laboratory and Workshop Notes in the *Journal* has been awarded to Dr. J. L. Miller and Mr. J. E. L. Robinson, of Messrs. Ferranti, Ltd., for their joint note entitled "A Three-Dimensional Adjustment of an Electrode in Vacuo."

SIR RONALD GRAHAM, the British Ambassador at Rome, presented Signor Mussolini on March 24 with the silver medal of merit conferred upon him by the Royal Society for the Prevention of Cruelty to Animals—the highest award in the gift of the society—in recognition of his recent action in making the Island of Capri a bird sanctuary.

OFFICERS of the New York Branch of the American Psychological Association were elected at the recent New Haven meeting as follows: *Honorary President,* Dr. J. McKeen Cattell; *Directors,* Dr. H. E. Garrett, Columbia University, and Dr. H. S. Langfeld, Princeton University.

OFFICERS of the Ray Society, London, were elected at the annual meeting held on March 22, as follows: *President,* Sir Sidney Harmer; *Treasurer,* Sir David Prain, and Dr. W. T. Calman, *Secretary.*

AT the annual meeting of the Physical Society, London, the following officers were elected: *President,* Professor A. O. Rankine; *Vice-president,* Professor W. Wilson; *Secretaries,* Dr. Allan Ferguson, Dr. Ezer Griffiths; *Foreign Secretary,* Professor O. W. Richardson; *Treasurer,* Mr. R. S. Whipple; *Librarian,* Dr. J. H. Brinkworth; new members of council, Professor E. V. Appleton, Dr. L. F. Bates and Dr. L. Hartshorn.

DR. PHILIP BARD, assistant professor of physiology at the Harvard Medical School, has been appointed professor of physiology at the School of Medicine of the Johns Hopkins University.

DR. ROBERT B. MACLEOD, formerly an honor student in psychology and philosophy at McGill University and winner in 1927 of the Moyse Traveling Scholarship in the Classics, has been appointed an assistant professor in psychology at Swarthmore College.

IN the Bell Telephone Laboratories, Vice-president H. P. Charlesworth has resigned to accept the position of assistant chief engineer of the American Telephone and Telegraph Company. Dr. E. H. Colpitts, who has been appointed to succeed him, is assistant vice-president of the American Telephone and Telegraph Company in charge of the Development and Research Department under Dr. F. B. Jewett, vice-president.

SENATORS Kendrick, Hayden, McNary and Carey are urging the retention of Dr. Elwood Mead as commissioner of reclamation under the new administration. The recommendation is based on Commissioner Mead's long service in various government departments in the interest of irrigation and drainage works. He has devoted nearly forty years to reclamation projects in the West. In 1924 he was appointed commissioner of the Reclamation Service by President Coolidge. Secretary of the Interior Harold L. Ickes is reported to have said that he would give the recommendation every consideration.

DR. EDWARD H. GRAHAM, assistant curator of botany at the Carnegie Museum, Pittsburgh, and Mrs. Graham, will leave on April 15 on a botanical collecting expedition of several months to the southeastern Uinta Mountains in the vicinity of Vernal, Utah, in order to obtain representatives of the spring flora and thus augment the collections made by the same party in the summer and fall of 1931.

DR. JOHN C. MERRIAM, president of the Carnegie Institution of Washington, was the chief speaker at the Jefferson Day exercises at the University of Virginia on April 13.

DR. A. V. KIDDER, chairman of the division of historical research of the Carnegie Institution of Washington, will give a lecture at the annual meeting of the American Philosophical Society on Friday evening, April 21, on "Mayan Explorations and Their Results."

DR. HARRY BOYER WEISER, professor of chemistry at the Rice Institute, gave the annual lecture of the Sigma Xi Club of the University of Alabama on March 30. His subject was "Colloidal Phenomena in the Formation of Gallstones."

THE Cutter Lectures on preventive medicine at the Harvard Medical School will be delivered on April 17 and 18, at 5 P. M., by Dr. Eugene L. Opie, professor of pathology in the Cornell University Medical College, on "The Epidemiology of Tuberculosis."

ROBERT FECHNER, vice-president of the Interna-

tional Association of Machinists and a lecturer on labor questions at Harvard University and Dartmouth College, has been appointed by President Roosevelt to be director under the unemployment reforestation act. Those present at the conference following which the appointment was made were Horace Albright, director of the National Park Service; John D. Coffman, fire control expert of the National Park Service; William G. Howard, director of lands and forests of the New York Conservation Department; R. Y. Stuart, chief United States forester; C. H. Granger, assistant chief forester; Colonel Duncan K. Major, Jr., of the general staff of the War Department, and W. Frank Parsons, of Chicago. This committee will direct the preliminary work and will have offices in the Interior Department.

THE Committee on Scientific Research of the American Medical Association has granted to Professor Ludwig A. Emge, associate professor at Stanford University, and his associates a grant to be used toward a study of the effect of pregnancy on tumor growth. This study forms part of a more extensive study on the behavior of benign tumor growth, which is now in its fifth year. A grant has also been made to Dr. Arthur Grollman, associate professor of pharmacology and experimental therapeutics at the Johns Hopkins University, to aid in work on the hormone of the adrenal cortex.

DR. T. WAYLAND VAUGHAN, director of the Scripps Institution of Oceanography of the University of California at La Jolla, and Mrs. Vaughan, have returned from a journey around the world, which started last August and has taken them as visitors to the principal oceanographic stations.

THE April lecture to the faculty and students of the School of Medicine, the George Washington University, on the Smith-Reed-Russell Society series was given by Dr. William H. Howell, chairman of the National Research Council. He spoke on the "Recollections of a Physiologist during the Past Half Century." The regular faculty seminar for April was given by Professor George B. Roth, of the department of pharmacology, who spoke on "The Arsphenamines; their Nature and Behavior."

THE scientific session of the American Heart Association will be held on Tuesday, June 13, from 9:30 A. M. to 5:30 P. M., in the Knickerbocker Hotel, Milwaukee, Wisconsin.

THE fourth annual Connecticut Valley Student Scientific Conference is meeting at Wesleyan University on Saturday, April 15. The conference is modeled after the meetings of the American Association for the Advancement of Science. The colleges represented are Amherst, Dartmouth, Mt. Holyoke, Smith, Massachusetts State, Connecticut State, Springfield, Trinity, Connecticut and Wesleyan. About seventy-five titles of papers or demonstrations appear on the program. It is expected that about three hundred students will attend. The conference is organized entirely by the graduate students and undergraduates of the colleges concerned.

APPLICATIONS for grants from the Cyrus M. Warren Fund of the American Academy of Arts and Sciences should be in the hands of the chairman of the committee, Professor James F. Norris, Massachusetts Institute of Technology, Cambridge, Mass., not later than May 15.

A DAVID ANDERSON-BERRY GOLD MEDAL, together with a sum of money amounting to about £100, will be awarded in July, 1935, by the Royal Society of Edinburgh to the person, who, in the opinion of the council, has recently produced the best work on the nature of x-rays in their therapeutical effect on human diseases.

ANNOUNCEMENT is made of a fellowship for graduate study at the medical faculty of the University of Geneva providing for tuition and a stipend of 3,000 Swiss francs (about $600) for the academic year, 1933–34. To be eligible, a candidate must be an American citizen, a graduate of an approved American medical school or the holder of a master's or doctor's degree in a science related to the medical field and must have a thorough knowledge of the French language. The fellowship will be administered by the Swiss American Student Exchange under the auspices of the Institute of International Education.

A HISTORICAL exhibit of maps, arranged by Dr. Erwin J. Raisz, is being shown at the Institute of Geographical Exploration, Harvard University. Many of the maps are originals, and come from the collections of Widener Library and Dr. Hamilton Rice. In addition to the maps, there are shown a number of old instruments connected with navigation and surveying, loaned by the Peabody Museum of Salem. The exhibit, open from 9:30 to 4:30 o'clock every day except Saturday and Sunday, will continue until May 1.

FREDERICK S. DELLENBAUGH, who was artist and one of the topographers with Major Powell in his second descent through the canyons of Green River and the Colorado, in 1871 and 1872, has presented the flag of Major Powell's boat, the *Emma Dean*, to the National Museum in Washington. The flag was made in Salt Lake City in 1871 by Major Powell's sister, Mrs. Ellen Powell Thompson. Major Powell's boat

was named after his wife. There were two other boats, the *Nellie Powell,* named after Mrs. Thompson, and the *Cañonita.*

THE Bureau of Ethnology has received the first report of the field activities of the party undertaking archeological reconnaissance in the eastern section of Honduras, made up of Dr. W. D. Strong, of the bureau staff, Alan W. Payne, and Norman Haskell. The report states that on February 10 the party left Puerto Castilla, proceeded to the mouth of the Patuca River, and went upstream. Studies were undertaken on the Guampu and Cuyamel Rivers, tributary to the Patuca. Two archeological sites marked by the presence of earth mounds were studied and excavated. The few remaining Sumu Indians were encountered, and a brief study was made of them. The conclusion was reached that the Maya culture did not extend that far to the eastward, as nothing indicative of this culture was found. The party learned that several hundred Sumus had been living on the river until four years ago, when an epidemic of smallpox swept them away. The next trip to be made will be from the westward of the Patuca Valley overland *via* muleback into the mountain region.

DISCUSSION

A CIVILIZATION WITHOUT NATIVE MATHEMATICS

IN a recent number of the historical periodical entitled "Quellen und Studien zur Geschichte der Mathematik, Astronomie und Physik," volume 2 (1932), page 255, there appears an article by P. L. van Hee, in which it is stated that if the Chinese mathematical books of every epoch would disappear science would suffer no loss as regards mathematics. It is claimed here that China has contributed nothing towards raising the edifice of modern mathematics, but that the mathematics which appears now in the Chinese literature is due to other nations and was often credited by Chinese writers to natives of their own country. Among the recent writers who are said to have been misled by these false claims is Y. Mikami, whose work entitled "The Development of Mathematics in China and Japan," 1913, is widely known and has been frequently referred to as an authority.

There is a remarkable contrast between the recent historical developments relating to China and those relating to Egypt and Babylonia. In the former case these developments seem to tend to show that their early mathematical attainments were overestimated, while in the latter they were underestimated, especially as regards Babylonia. In particular, the issue of the periodical noted above contains also the remarkable announcement that the ancient Babylonians had a rule equivalent to a general formula for the sum of the squares of the first n natural numbers. It was formerly supposed that the first discovery of such a rule was due to the ancient Greek mathematicians. A few years ago it was announced that the ancient Egyptians had a rule which is equivalent to our modern formula for the area of a sphere, but this seems now to be incorrect, having been due to a mistranslation.

The chief interest in the article to which we referred at the beginning of this note is due to the fact that it exhibits a lack of mathematical initiative on the part of the Chinese extending over a long period of time. When mathematics was introduced from other countries it received considerable attention and some of it was permanently retained, but no definite evidences of native advances seem as yet to have been established. The exaggerated claims made by some of the Chinese writers have really been harmful to the reputation of their country and they have made it difficult to form a correct judgment as regards their possible contributions It seems clear, however, that from the standpoint of mathematics ancient China was far behind ancient Egypt and ancient Babylonia. Their ancient as well as their modern civilization exhibits unusual mathematical weakness and many of the references to their achievements along this line are untrustworthy according to some of the most recent investigations.

G. A. MILLER

UNIVERSITY OF ILLINOIS

THEORIES OF CORTICO-ADRENAL FUNCTION

WITHIN the past year three theories of cortico-adrenal function have been advanced. They postulate that the adrenal cortex (1) prepotently regulates carbohydrate metabolism,[1] (2) produces a general tissue hormone,[2] (3) controls the circulating blood volume.[3] The first appeared about a year ago, the second shortly after, and the third in January of this year.

In presenting their theory of blood-volume regulation and the relation of the adrenals to shock, Swingle and his associates ride rough-shod over other hypotheses. "None," they state, "have materially advanced (*sic*) the problem of cortical function." Not even a foot-line was given to bibliographic mention of the earlier theories mentioned above.

It is not *in justitia scientiae* merely that mention should be made of the praiseworthy contributions of

[1] S. W. Britton and H. Silvette, *Amer. Jour. Physiol.,* 100: 701, 1932.

[2] F. A. Hartman, K. A. Brownell and J. E. Lockwood, *Endocrinology,* 16: 521, 1932; *Amer. Jour. Physiol.,* 101: 50, 1932.

[3] W. W. Swingle, *et al.,* SCIENCE, 77: 58, 1933.

Hartman and his colleagues toward the elucidation of cortico-adrenal problems. Contemporaneously with, if not prior to Swingle and Pfiffner, the Buffalo investigators produced a potent extract of the adrenal cortex, and they have published extensively on its effects. Furthermore, they have formulated a theory of cortico-adrenal function as noted above, and supported it with considerable experimental evidence.

That the adrenals are of importance in maintaining a normal circulation has been known for many decades, and the ideas of Swingle and his associates are not at all novel. In a small section of a review a few years ago, one of us (Britton)[4] drew attention to more than a score of observations on the subject. Antedating by two years the recent report of Swingle *et al.*, there appeared a comprehensive experimental study by Wyman and Suden on "The blood volume in suprarenal insufficiency, anaphylactic shock and histamine shock."[5]

Our own observations lead us to conclude that changes in blood pressure and in the amount of circulating blood are indirect and illustrative only of the general effects of adrenalectomy throughout the body. We have sought an understanding of the *underlying* chemical changes and conditions in adrenal insufficiency which are antecedent to, or take precedence over, because of their critical nature, the altered permeability relationships in the body.

Breakdown to the point of utter collapse of the normal carbo-metabolic processes appears to us still to constitute the primary critical contingency in adrenal insufficiency. The adrenalectomized animal suffers from glucose and glycogen lack, which becomes progressively more severe after the operation, and parallels the development of symptoms. All the symptoms, too, are compellingly suggestive of severe hypoglycemia. We have never observed such profoundly critical glucose and glycogen disturbances in any other cachexic status which involves carbohydrate metabolism—*e.g.*, the cachexia following hepatectomy or pancreatectomy or heavy insulin dosage. Cortico-adrenal extract appears to have a primary effect, moreover, in restoring promptly the normal carbohydrate levels.

Animals dying of adrenal insufficiency show convulsive seizures some hours before death which are identical in type with those observed in insulin hypoglycemia. By contrast we have never observed such convulsions in animals in which the circulating blood volume has been markedly reduced by hemorrhage and other operative procedures.

It may be that carbohydrate deficiencies do not explain the whole problem of adrenal insufficiency. Glucose does not prolong the lives of adrenalectomized animals many days. Similarly, carbohydrate injections only slightly extend the survival of hepatectomized animals. In a number of cases we have observed, too, that glucose does not restore severely insulinized animals. Many substances are furthermore known to reduce the blood sugar in diabetes, but that without remedy. It is to be emphasized in this connection that we have been concerned for the present simply with *the first crucial signs of failure* in the adrenalectomized animal. That there occurs primarily and fundamentally a failure in glycotaxis in the body appears as best fitting the mass of evidence at hand.

Swingle and his colleagues state that in cases of adrenal insufficiency blood dilution "never occurs . . . unless the hormone is injected." In our experiments we have observed that restoration of the normal blood volume of adrenalectomized animals may readily be brought about by saline injections. The symptoms of insufficiency are not at all ameliorated by such restoration, however, nor is life even slightly prolonged. In contrast, augmentation of the blood sugar by glucose injections alleviates the symptoms very rapidly, and lengthens significantly the survival period.

We have observed that the adrenalectomized animal is somewhat hydrated, rather than dehydrated.[6] Increased amounts of water are held in the hepatic and muscular tissues. The blood plasma and total blood volume are in contrast reduced, but not until symptoms are developed are these reductions noteworthy. Fluid accumulations in the liver and muscle in adrenal insufficiency more than balance the loss of fluid by the blood.

We gain the impression from our data that water is more necessary for the maintenance of normality conditions in the liver and muscle than for any of the demands of the circulation, important though the latter may be. Furthermore, one of the earliest and most striking effects of cortico-adrenal extract which we have observed is the *elimination* of fluid by the production of a striking diuresis. Space limits can not be imposed on for further considerations here.

The most critical emergency in the career of the adrenalectomized animal results from virtually complete disappearance of liver glycogen, and concomitantly profound reduction of blood sugar, as well as muscle glycogen. Thus, severe hypoglycemic convulsions supervene, and death results during the convulsive seizures. Our data compel adherence to our first-proposed theory of the prepotent function of the adrenal cortex—that of the regulation, in cooperation

[4] S. W. Britton, *Physiol. Rev.*, 10: 617, 1930.

[5] L. C. Wyman and C. tum Suden, *Amer. Jour. Physiol.*, 94: 579, 1930.

[6] H. Silvette and S. W. Britton, *Amer. Jour. Physiol.*, (in press), 1933.

with other tissues or secretions, of carbohydrate metabolism in the organism.

S. W. BRITTON
H. SILVETTE

UNIVERSITY OF VIRGINIA

THE "SPREAD" OR "SCATTER" OF THE INFLUENCE FROM A REWARD, IN RELATION TO GESTALT DOCTRINES

IN SCIENCE of February 10, I reported the discovery of the "spread" or "scatter" of the influence of a reward, and especially the significance of the phenomenon as an independent proof of the so-called law of effect. Circumstances prevented a prompt reply to Ogden's criticisms (SCIENCE, March 3) and the need has perhaps vanished as a result of Boring's ingenious *modus vivendi* for Gestaltists and connectionists (SCIENCE, March 24). But I venture to note the following:

The "whole process" in my experiments consists of 40 words chosen at random said by the experimenter, to each of which the subject responds by a number from 1 to 10, or of equally arbitrary multiple choices. An announcement of "Right" after one of the 40 word-number units in the experiments certainly does not strengthen or confirm the whole process equally. An announcement of "Wrong" seems to the observers to be as "final" or as "consummatory" of, the connection it follows as an announcement of "Right." Certainly any difference in this respect is very small, but the difference in strengthening of the connection is enormous. And this enormous difference uniformly goes with the satisfyingness of the after-effect.

My note in SCIENCE presented evidence for these conclusions: (1) The strengthening of the connection which the reward immediately follows and to which it belongs does not occur indirectly by reason of repetitions or rehearsals of the connection or by way of memories that such and such a number was right, or successful, or rewarded for such and such a word, because the announcements of "Wrong" have no negative influence comparable to the positive influence of the announcement of "Right."

(2) The reward does not have to search out the "right" or "successful" act by any mysterious power and attach itself to it, as Peterson has objected. It strengthens whatever its physiological equivalent influences in the neurones.

(3) The reward strengthens chiefly the connection which immediately precedes it and of which it is (by sophisticated humans) felt to be the after-effect. But it also strengthens the connections one and two steps further back or forward, though these were definitely punished and most emphatically did *not* belong to the reward in the Gestalt's meaning of "belong" if I understand them. Each belongs to its punishment. Nothing happening to the subject equally near the time of the reward could belong to it much less in the sense of forming with it a "perfectly integrated unit."

In the very different sense in which I use the word, the reward may belong to these preceding and succeeding connections, though rather tenuously and indirectly, as neighboring tasks related only by the conditions of the experiment.

I can guarantee this. Let any Gestaltist choose a hundred multiple-choice tasks as "discrete and independent" one from another as he can find or make, each composed of a situation and n responses from which choice is to be made such that the situation and the responses are as "discrete and independent" from each other as he can find or make, and let him choose rewards and punishments as "discrete and independent" from anything in the tasks as he can find and make. Then the situation-response connection which has a reward attached to it utterly arbitrarily by the experimenter will be strengthened thereby, so long as it is a satisfying after-effect of that connection to the learner. And the influence of the reward may, and often will, spread or scatter so as to strengthen other connections in the physiological neighborhood.

EDWARD L. THORNDIKE

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STRATIGRAPHIC NOMENCLATURE

IN SCIENCE (Vol. 76, p. 489) Professor G. D. Harris, of the Paleontological Laboratory, Cornell University, writes: "Perhaps others as well as the writer have often been at a loss for a concise, logical and self-explanatory term for indicating all that portion of the geologic sequence (or geologic time) below or antedating the Cambrian system (or time). Strangely enough, the embarrassment becomes more acute if one searches for a term to include the Paleozoic, Mesozoic and Cenozoic."

I want to make the statement, that in my "Textbook of Geology" (*Lehrbuch der Geologie*, Wien, 1924) I introduced the term "Euzoische Schichtfolge" (Euzoic sequence), which includes the Paleozoic, Mesozoic and Cenozoic.

F. X. SCHAFFER

NATURHISTORISCHES STAATSMUSEUM
WIEN

FREQUENCY OF VERTEBRATE FOSSILS IN RIVER DEPOSITS

THE following observation, dated "Monday 17, 1805," taken from "History of the Expedition of Captains Lewis and Clark,"[1] is of more than usual interest

[1] Vol. I, p. 352, New Amsterdam Book Company, New York.

to vertebrate paleontologists. The scene was at the great Falls of the Missouri.

There are vast quantities of buffalo feeding on the plains or watering in the river, which is also strewed with the floating carcases and limbs of these animals. They go in large herds to water about the falls, and as all the passages to the river near that place are narrow and steep, the foremost are pressed into the river by the impatience of those behind. In this way we have seen ten or a dozen disappear over the falls in a few minutes. They afford excellent food for the wolves, bears, and birds of prey; and this circumstance may account for the reluctance of the bears to yield their dominion over the neighborhood.

ELLIS W. SHULER
SOUTHERN METHODIST UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

APPARATUS FOR SLIDE TECHNIQUE

THE apparatus illustrated in the following figures has been found very practical and a great time-saver in the preparation of slides. The small cost of materials and time required for construction are negligible, compared with the efficient service they render.

WARMING PLATE FOR SPREADING PARAFFIN SECTIONS

The warming plate shown in Fig. A is practically

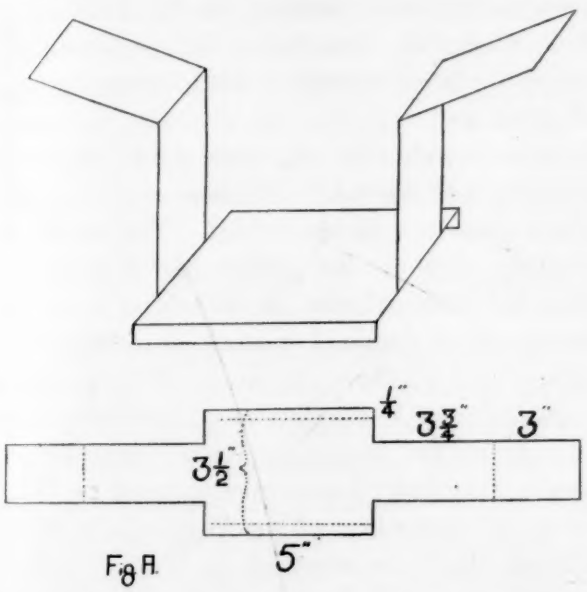

Fig. A.

self-explanatory for its use in spreading paraffin sections. It is made from a single sheet of thin copper and heated by conduction from alcohol flames under the wing tips. By placing bits of paraffin, having the same melting point as that used in preparing the tissue, on the ends of the stage, the best working temperature can be determined and controlled by moving the flames closer to or farther away from the wing tips. The small diagram gives the dimensions and shows the shape of the sheet before being bent. The height of the wings could be changed to compensate for the lamp to be used.

SLIDE DRYING CABINET

In preparing a large number of slides for study, it is advantageous to hasten the drying of the balsam after the covers are in place. The slide drying cabinet in Fig. B is a very efficient piece of apparatus for

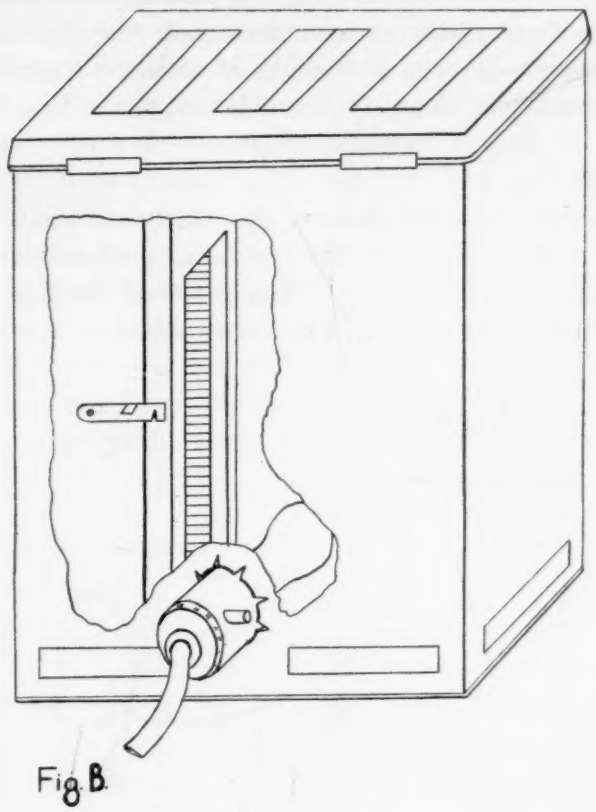
Fig. B.

this purpose. It was made from a cracker can, two slide boxes, a small sheet of copper and a light socket with several feet of cord.

The light socket was placed in the rear wall so that the bulb would just clear the bottom and give room for a slide box to stand on end on either side. A 25 watt clear bulb furnishes sufficient heat for good circulation of air without having a temperature over 50° C. The air enters through the openings at the bottom, passes over the slides and goes out through the openings in the lid. A copper slide, supported beneath the lid, makes it possible to close the openings if a higher temperature is desired.

Through the opening in the back of the cabinet a slide box can be seen in position. The lids and bottoms were cut out, leaving just enough edge to hold the slides. Catches on the sides hold the lids firmly in place. After 48 hours in the drying cabinet slides are ready for their final cleaning and polishing.

EMORY S. JAMES
OHIO WESLEYAN UNIVERSITY

A SIMPLE DEVICE FOR THE PERFUSION OF THE MAMMALIAN HEART

IN the course of some experiments in which we used the heart-beat to test the properties of some balanced salt solutions, the apparatus here described was devised. Most devices for the perfusion of the mammalian heart[1,2,3] are elaborate and present considerable difficulties in manipulation. While this is undoubtedly necessary in experimentation on some physiological function of the heart we found the simplified apparatus here presented adequate to our purpose. We are presenting it with the expectation that a device so easily assembled might be found useful in lecture demonstrations or classroom experiments.

There are three factors, the control of which presents the greatest difficulty in the perfusion of the mammalian heart: (1) Temperature of the fluid; (2) Pressure of the fluid; (3) Oxygenation.

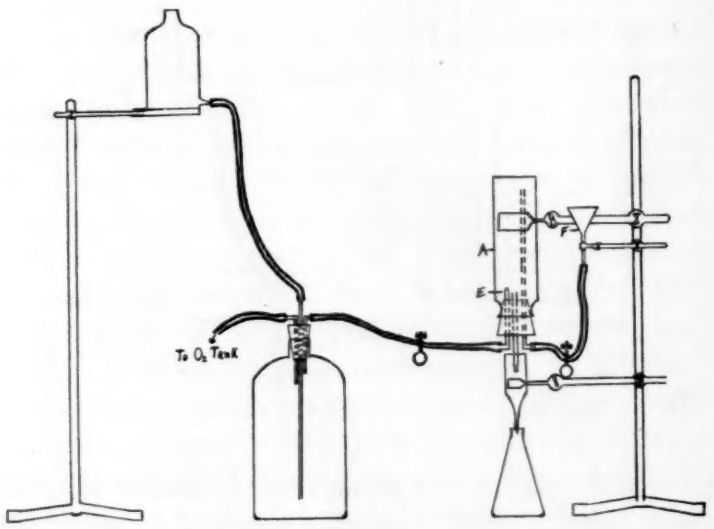

FIG. 1.

As far as the temperature is concerned it is merely necessary to control it within a degree or a degree and a half. This is readily accomplished by means of the vacuum flask (A). The cannula to which the heart is attached is inserted in rubber tubing which is attached to a piece of glass tubing inserted in the rubber stopper of the flask. The cannula and tubes are all as short as possible to avoid cooling of the fluid. The heart is suspended in a filter tube the mouth of which can be closed by a wad of moist cotton. The temperature of the heart is maintained by the passage of the perfusion fluid through it. Unless the room is very warm it is desirable to warm the filter tube by an electric lamp suspended near it. However crude this temperature control may seem to the physiologist who is accustomed to working with apparatus capable of control to a tenth or even a hundredth of a degree C., we have found it quite sufficient to keep the heart beating vigorously 6 to 8 hours.

Pressure and oxygenation are controlled by a single apparatus. Medical oxygen is released from a cylinder into a gasometer consisting of two bottles at different levels, connected by a rubber tube, the lower partly filled with water. As pressure is increased water is displaced within the lower bottle and rises in the upper. Pressure is controlled by the difference in the level of the bottles. The oxygen is conducted from the gasometer through a tube drawn out into a capillary (E) inserted in the rubber stopper of the flask, where it bubbles through the perfusion fluid. This gas is then allowed to escape through the trap (F) consisting of a funnel on a rubber tube, filled with water to counterbalance the pressure in the gasometer. This funnel may be raised and lowered to keep the pressure constant as the fluid within the flask is used. By this device the perfusion fluid is very readily kept saturated with oxygen at any desired pressure.

In our experiments we have used hearts of rat, guinea-pig and rabbit. Of these we have had the greatest success with the rabbit. The rat heart and frequently that of the guinea-pig stopped beating during the manipulation in attaching it to the apparatus. If it resumed beating at all the beat was irregular and of short duration. This is apparently the phenomenon of fibrillation or delirium cordis.[4]

Our procedure in setting up an experiment is as follows: The flask, previously warmed by the introduction of water heated to 37.5° C, is filled with perfusion fluid also warmed to 37.5° C. The fluid, preparatory to the beginning of the experiment, is saturated by a lively stream of oxygen. The animal is killed by a blow on the head and bled quickly from the carotid artery. The heart is immediately removed, taking particular care to leave the systemic aorta sufficiently long to accommodate the tip of the cannula. The heart is then placed in a small dish of warm perfusion fluid and permitted to beat in it, under the slight pressure of the finger, to clear itself of blood. The aorta is carefully dissected away from the surrounding tissue to make sure that none of the nerves will be tied in the ligature. The cannula, already attached to the flask, has now a slow stream of perfusion fluid, controlled by a clamp on the rubber tube (C), passing through it. The heart is lifted by the aorta, and the aorta is drawn over the tip of the cannula. The aorta is held in position so that the cannula does not protrude beyond the semi-

[1] Knowlton and Starling, *Journ. of Phys.*, 44: 206. 1912.
[2] Anrep and Hausler, *Journ. of Phys.*, 65: 357. 1928.
[3] Gunn, *Journ. of Phys.*, 46: 506. 1913.
[4] Starling, "Human Physiology," p. 758. Philadelphia. 1926.

lunar valves and in this position is firmly tied. The clamp on the rubber tube is then completely opened. The filter tube is raised to enclose the heart and its top closed with moist cotton.

For perfusion simply to maintain the heart-beat as long as possible we have had the greatest success with Locke's fluid as given by Baylis,[5] with the difference that it was buffered with 100 mg of sodium bicarbonate and 50 mg of primary sodium phosphate per liter.

We have found that the size and shape of the cannula and the care with which it was tied in the proper position in the aorta were very important in the success of the experiment. The cannula must be sufficiently large to permit the fluid expelled by the beating heart to flow rapidly back through it. The tip of the cannula must be above the semi-lunar valves so that at the beginning of the beat the full pressure of the perfusion fluid is not exerted on the wall of the ventricle. A complete relaxation of the ventricles is necessary to insure a proper perfusion of the coronary vessels. This will not be possible if the cannula projects beyond the semi-lunar valves into the left ventricle and maintains a constant distention of the ventricle. Even when the cannula is correctly inserted a certain amount of fluid accumulates in the ventricles. This may come from leakage past the valves or from the Thebesian vessels. It is for the rapid release of the pressure of this fluid as the heart contracts that it is necessary to make the aperture of the perfusion cannula as large as possible. If, in spite of all precautions, a distention of the ventricle does develop during the experiment it may be relieved by inserting a cannula through the pulmonary vein and the mitral valves into the ventricle. It is obviously necessary to be certain that the tip of the perfusion cannula does not project so far into the aorta that its wall occludes the opening into the coronary arteries.

As the perfusion continues, the pressure in the gasometer is maintained at a constant level by admitting oxygen from the tank as necessary. Oxygen is permitted to bubble slowly through the perfusion fluid by adjusting the level of the funnel of the trap. If the fluid in the flask becomes exhausted it is merely necessary to fill another flask and replace the one originally used.

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SPECIAL ARTICLES

THE PERIHELION OF MERCURY

THE law of Newton states that every particle of matter in the universe attracts every other particle with a force that varies directly as the product of the masses and inversely as the square of the distance. For two bodies this law gives accurate results (a), as they are very far apart and (b), as their dimensions are small in relation to the distance between them but, when two bodies of substantial size are near together and when a small body is near to a large one, there is ground for doubting its precision.

Let the formula for the force of gravitation F, be written,

$$F = G\frac{M_1}{d} \times \frac{M_2}{d}$$

G being the gravitational constant, M_1 and M_2 the individual masses of two bodies and d the distance between their centers. From this it may be inferred that gravitation is the resultant of two forces each varying directly as the mass which produces it and inversely as the distance from the other. These forces are directed toward each other. Each acts at the distance d from the other and their product is the resultant which is called Gravitation.

If the above proposition be true, then the actual attraction between two spheres can not be the same as that which is computed on the supposition that the entire mass of each is concentrated at its center as on the basis of the inverse square.

In Fig. 1, M_1 and M_2 are homogeneous spheres, M_2 being very small, and $M_1M_2 = d$. The inner circle

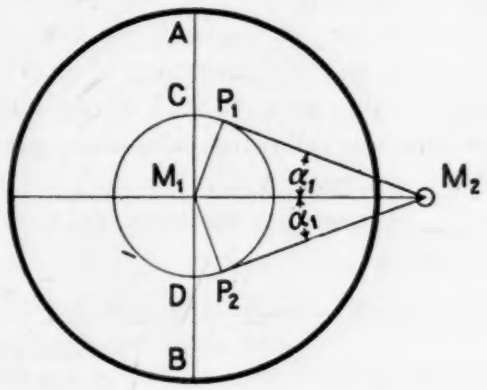

FIG. 1

CP_1P_2 DC is drawn so that $M_1C = 0.4244M_1A$ and it is, therefore, the locus of the centers of gravity of all the halves of the circle AB which is a diametral section of M_1; M_2P_1 and M_2P_2 are tangents to this circle and P_1 and P_2 are the points at which the resultant attractions on M_2 of the upper and lower semi-circles of M_1 may be considered as concentrated. The value of the attraction of each of the semi-circles, if a rep-

[5] Baylis, "Principles of General Physiology," p. 211. London. 1927.

resent its area, is proportional to $a \cos\alpha_1$, where α_1 is the angle $P_1M_2M_1$ and, as the attraction varies inversely with the distance, the attractive force exerted by each semi-circle on M_2 is, if g is a constant and since P_1M_2, the distance at which this force acts is $d \cos\alpha_1$,

$$\frac{ga\cos\alpha_1}{d\cos\alpha_1} = \frac{ga}{d}$$

The attractive force of the upper semi-circle is exerted on M_2 in the direction M_2P_1 and its component along M_2M_1 is $ga\cos\alpha_1/d$ while, for the entire circle, the attraction is $g\ 2a\cos\alpha_1/d = g\ A\cos\alpha_1/d$. If now, the circle AB is rotated through 180° it will generate the sphere AB and what is true for each of its sections will be true for its mass. The attraction of M_1 for M_2 therefore is, $gM_1\cos\alpha_1/d$ and, in an exactly similar manner, the attraction of M_2 for M_1 is $gM_2\cos\alpha_2/d$. The total force of attraction F, which is that of Gravitation, between the two spheres is, then, the product of the individual forces, thus,

$$F = \frac{g\,M_1\cos\alpha_1}{d} \times \frac{g\,M_2\cos\alpha_2}{d} = g^2\frac{M_1\cos\alpha_1 \times M_2\cos\alpha_2}{d^2} \qquad (1)$$

and this, when G is written for g^2, is an advanced statement of the law of gravitation.

The relative acceleration f of the spheres M_1 and M_2 therefore is,

$$f = G\frac{M_1\cos\alpha_1 + M_2\cos\alpha_2}{d^2} \qquad (2)$$

In nearly all cases $\cos\alpha_1$ and $\cos\alpha_2$ are so close to unity that no practical difference between the above formula and that of Newton can be detected. However, the value of $\cos\alpha$ for the Sun, at the distance of Mercury, is such as to point a reason for the observed "advance" of the perihelion of that planet. To this end the acceleration of Mercury has been computed for three positions with the center of gravity of the Sun's semi-circular area at 0.28 of its radius from its center and the following tabulation presents the values of the exponent of d in Newton's law which are necessary to produce the accelerations given by formula (2) above.

Position of Mercury	Necessary exponent of d in Newton's Law
Aphelion	2.00000013
Mean	2.00000019
Perihelion	2.00000031

Allowing for the longer time spent by Mercury in the outer portion of its orbit, the mean value of the exponent of d necessary to conform the law of Newton with formula (2) is 2.000000192 and this is comparable with the value of 2.000000161 which was suggested[1] in order to account for the then known advance of 42″ per century in the position of the perihelion point. Now, if the exponent 2.000000161 accounts for an advance of 42″, then the exponent 2.000000192 represents an advance of 50.″1 per century, which value compares with the recent determination[2] by Morgan of 50.″9.

The quantitative agreement which has been shown between the observed and the computed values for the advance of Mercury's perihelion is of especial interest and the principles on which this finding is based extend into many fields. The placing of the center of gravity of the sun's semi-circular section at the 0.28 point of its radius is merely a recognition that the density of the sun increases toward its center. In a homogeneous sun this ratio would be 0.4244.

A detailed outline of the studies on which the conclusions herein presented are founded is being prepared.

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SOME FACTORS INFLUENCING THE SUSCEPTIBILITY OF ALBINO RATS TO INJECTIONS OF SODIUM AMYTAL[1]

IN an earlier account[2] of the use of sodium amytal (Lilly) as an anesthetic for albino rats a sex difference in the reaction to the drug was noted. The concentration of the solution in which the anesthetic was given was found to have a marked effect upon its efficacy. These two facts have been investigated in an attempt to analyze further the action of the anesthetic.

A record has been kept of the amount of sodium amytal in a 10 per cent. solution required to produce anesthesia in male animals of weights ranging between thirty and four hundred grams. These animals have been anesthetized in experiments of various types during the past year and a half. From these individual records Fig. 1 has been composed. A total of over one thousand observations have been made on animals of varying weights.

In the graph the weight of the animals has been plotted against the milligrams of sodium amytal in a 10 per cent. solution necessary to produce a deep anesthesia from which the animal will recover. This extends the observations on the dosage required for

[1] Simon Newcomb, article, "Gravitation." Encyclopaedia Britannica, 9th Edition.

[2] H. R. Morgan, *Jour. Optical Society of America*, Vol. 20, p. 228.

[1] The sodium amytal used in these experiments was generously furnished by Eli Lilly and Company.

[2] J. S. Nicholas and D. H. Barron, *Jour. of Pharmacol. and Exper. Therapeut.*, 46: pp. 125–130, 1932.

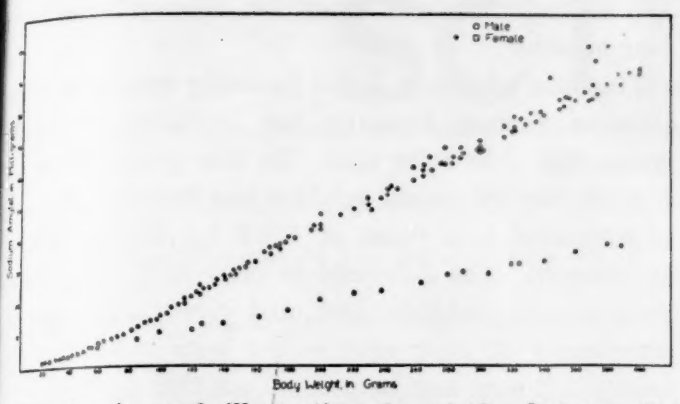

FIG. 1. A graph illustrating the relation between the body weights of albino rats and the amount of sodium amytal in milligrams necessary to produce deep anesthesia.

male rats which in a previous report were obtained only upon males ranging between one hundred and twenty-five and two hundred and fifty grams in weight. For comparison, the dosage for females of a corresponding range of weights has also been plotted. The graph therefore demonstrates the sex difference in the reaction to sodium amytal and defines clearly the weight at which this sex difference appears.

To determine whether or not the greater resistance of the male rats was to be associated with the presence of the gonads, ten adult male rats weighing about one hundred and seventy-five grams each were castrated. Six weeks later these animals were weighed and given the male dose normal for their weight. None of the animals survived. A second group of five adult animals about two hundreds grams in weight were castrated and anesthetized at the end of six weeks. These animals were more resistant to sodium amytal than females but were markedly less resistant than normal males.

A third series of ten young males about thirty grams each were castrated. Each week following castration the animals were anesthetized. The normal male dose for their weight was invariably necessary to produce deep anesthesia. These animals were castrated before they had developed the sex difference in their reaction to sodium amytal; nevertheless they retained the resistance normal to uncastrated males throughout their growth and development. The resistance of males castrated before the sex difference has appeared, therefore, is unaltered, but males castrated when adults become definitely more susceptible.

Although not more than suggestive, it is interesting to note that the weight at which the sex difference appears—between fifty and sixty grams—is also the weight at which the differential growth relation of both the hypophysis and the suprarenals first appear between the males and females.[3] The female rat has the heavier hypophysis and suprarenal glands.

The effect of the dilution of the solution of sodium amytal with which anesthesia is produced has been discussed earlier. The animals were much more resistant to equal quantities of the drug if administered in more dilute solutions. This fact suggested that injections of mammalian Ringer's into the blood stream of an over-anesthetized animal might reduce the effectiveness of the original dose and aid in the recovery of the animal.

Both males and females were injected with one and a half times the normal dose for their weight. After the animal was well under the anesthetic the femoral vein was exposed and eight cubic centimeters of mammalian Ringer's—either warm or cold—was injected into the blood stream. The controls were anesthetized in the same way but were not injected with Ringer's. All the animals that received the injection of Ringer's solution (ten) recovered from the anesthetic. The ten control animals, however, all died from respiratory failure typical of over-anesthetized animals. This method of reducing the effectiveness of the drug by injections of Ringer's into the blood stream has proved of value in saving an occasional animal which is more susceptible to sodium amytal than the normal.

These facts appear to be directly related to the action of sodium amytal, for rats demonstrate no sex difference to nembutal. The dose for both males and females is the same as the male dose of sodium amytal in a ten per cent. solution. The injection of Ringer's into the blood stream of rats over-anesthetized with nembutal is not effective.

The injection and dilution experiments indicate that resistance to sodium amytal is in some way related to the water metabolism of the animal. This is further supported by the correlation between the time of the development of the sex difference in rats and the differential growth rate of the hypophysis and the suprarenal glands. The castration experiments then imply that in the adult the testes influence the water metabolism control, although when removed before this function is developed, other factors within the body compensate for their loss.

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SIBLING RESEMBLANCE AND ITS RELATION TO AGE INTERVAL

STOCKS[1] has recently published an investigation in which the resemblance of siblings in a number of

[3] H. H. Donaldson, "The Rat: Data and Reference Tables." Memoirs of the Wistar Institute of Anat. and Biol., No. 6, Philadelphia, pp. 469, 1924.

[1] Percy Stocks, "A Biometric Investigation of Twins and Their Brothers and Sisters," *Annals of Eugenics*, 4: 49–108. 1930.

physical and physiological traits has been examined to determine whether the interval between births of children of the same parents is related to degrees of resemblance. His results furnish no definite evidence that the interval between births has any influence on degree of resemblance in the traits studied. To date there has been published no direct attack of a similar nature upon the question of resemblance in mental traits.

For the past two years the author has been collecting data from intelligence tests administered to two or more members of a family with the idea of trying to reveal any relationship existing between age interval and degree of resemblance of siblings in mental capacity (within the limits to which paper and pencil tests measure mental capacity). The present results are based on the records of 1,012 pairs of native-born white siblings, representing 614 families and having age differences ranging between one and eleven years. Three groups, including superior, average and inferior ability, respectively, were obtained by drawing upon schools enrolling children from widely different socio-economic strata.

In all cases the two members of a pair were tested with the same tests and under similar conditions, in so far as this was possible. For example, children from any one school were all tested when they had progressed to a given grade level, so that the average age at test was approximately equal for the older and younger members of all pairs.

The principal method of analysis employed to discover any possible relationship existing between age interval and difference in intelligence was that of product-moment correlation. For each group of data this relationship was computed by entering the difference of a pair in I. Q. on the x axis, and their difference in age on the y axis. The obtained correlations, as will be seen from Table 1, indicate no tendency for children within a family, far apart in age, to resemble each other less than children born near together.

The data of Group I are probably most free from selective factors favoring the inclusion of bright young and dull older sibs. In this group the mean I. Q. of the 359 paired as older was found to be 117.6 as compared to a mean of 118.0 for the 359 paired as younger. The difference in mean I. Q. (.4) is less than its own probable error, and gives no evidence of superiority of later over earlier born members of a family. It may also be pointed out that the degree of sibling resemblance has been computed for each group of data. This has been done by entering the I. Q. of the older member of each pair on the x axis, and the I. Q. of the younger on the y axis. The resulting values for r were .49, .52 and .34, respectively. The first two of these are probably fairly accurate measures of the degree of sibling resemblance in representative groups; the latter is lower than the true degree of resemblance because of a marked restriction of range in the data employed.

TABLE 1

RELATION BETWEEN I. Q. DIFFERENCE AND AGE INTERVAL OF SIBLINGS

X = I. Q. difference
Y = Age difference in months

Group	r_{xy}	P.E.*	M_x	M_y	σ_x	σ_y	N*
I	−.001	.036	10.59	41.04	7.83	23.70	359
II	−.006	.049	11.55	32.34	8.04	15.78	188
III	+.058	.032	10.86	43.20	8.10	25.26	465

* The values of N given here, and employed in computing the values of P. E. here reported, are in each case the number of pairs, and, since some individuals entered more than one pair, are greater than the actual number of cases involved. These P. E. values are therefore slightly below the true probable errors.

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